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Wood preservatives: application methods

The successful preservation of timber depends as much on the way the preservative is applied as on the toxicity of the preservative itself. There are a number of different methods of application, which vary in effectiveness and in their suitability for different end-use situations. This digest outlines the various processes and their selection and lists the relevant standards and codes. Fuller details of all the processes can be found in 'Methods of applying wood preservatives'.

Under many conditions of use, timber of any species is liable to suffer damage from biological attack. Many of the commonly used woods are particularly susceptible, and the occurrence of decay or insect attack in buildings and structures frequently necessitates expensive repairs, sometimes within the first few years of service. This wastage of valuable timber and the consequent costs of repairs and maintenance can be avoided, however, by correct processing of timber. Proper preservative treatment will provide long-term protection against biological deterioration even under the most severe conditions of exposure.

Preservatives are divided into three types, tar-oil, water-borne and organic solvent; the main features of each are given in BS 1282 *Guide to the choice, use and application of wood preservatives.* A summary of the properties of the different preservatives is given in Table 1, together with the methods of application generally employed.

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Table 1 Classification of wood preservatives

Preservative types and ingredients		Treatment methods	Preservative properties
Tar oil Distillate from coal tar	1 Coal tar creosote to BS 144	Pressure Open tank	Resist leaching and are particularly suitable for external work. Have a characteristic odour, and can stain adjacent materials.
	2 Coal tar oil to BS 3051	Pressure Open tank Immersion Brush	Non-corrosive to metals, and treated timber presents no special fire hazard after a few months' drying. Not suitable normally for timber that is to be painted. Impart a degree of water-repellency to timber which helps in retarding dimensional movement.
Organic solvent Solutions of one or more organic fungicides/ insecticides in organic solvents, usually petroleum oil distillate	1 Copper naphthenate to BS 5056 2 Zinc naphthenate 3 Pentachlorophenol and derivatives 4 Tributyltin oxide 5 Chlorinated naphthalene 6 gamma-HCH 7 Dieldrin	Double vacuum Immersion Deluging Brush/spray	Most of the preservatives are resistant to leaching but some are subject to loss by evaporation: suitable for exterior and interior use. Not generally corrosive to metals, and non-staining. Treated timber clean in appearance and, when solvent has dried off, can usually be painted and glued satisfactorily. Treatment does not cause swelling of the timber and these preservatives can be employed on accurately machined wood and components without trouble from movement or distortion. Solvents are readily flammable, but once they have evaporated the treated timber presents no fire hazard. Water-repellent additives can be included to retard timber moisture changes in service.
Water-borne Inorganic salts dissolved in water	1 Copper/chrome/ arsenic to BS 4072 2 Copper/chrome to BS 3452 3 Fluor/chrome/ arsenate/ dinitrophenol to BS 3453	Pressure	(1) and (2) undergo chemical changes within the wood and become resistant to leaching: suitable for exterior and interior use. The others are leachable to some extent, but can be used outside if the wood is painted. Generally non-corrosive to metals, non-staining and non-flammable. Timber must be re-dried after treatment: clean (but sometimes coloured) in appearance: can be painted and glued satisfactorily. (2) and (3) now little used in UK.
	4 Disodium octaborate	Diffusion	

Brushing and spraying

The preservative should be flooded over the timber so that as much as possible is absorbed, particularly into end-grain, joints and cracks. A second application can be made after a few days if required. Most preservatives sold for these methods of application are of the organic solvent type and can be applied satisfactorily at ambient temperatures. Creosote can be heated to obtain better penetration and a cleaner treatment. External woodwork is best treated in the summer when the wood is dry and in a more absorbent condition.

The penetration obtained is normally shallow but where attack is slow or intermittent, satisfactory protection can often be obtained if retreatment is carried out every few years, but all surfaces must be accessible to the preservative.

Brushing and spraying are more acceptable where protection only against insect attack is required, provided the preservative solution contains a specific contact insecticide.

Deluging
Timber is fed through a tunnel on a conveyor system as an organic solvent preservative is sprayed or flooded over it. The wood is in contact with the preservative for only a few seconds and the treatment equates to a short dip (about 10 seconds) or a flood brush application.

Immersion
Timber is submerged in a bath of preservative liquid for a period which can range from a few seconds to several minutes (usually called 'dipping'), to several hours or days ('soaking' or 'steeping'). Organic solvent preservatives are widely used, creosote sometimes.
The degree of treatment obtained depends on the preservative fluid used, the species of timber and the period of immersion. In pine sapwood, for example, penetration is much deeper than in less permeable woods such as spruce and hemlock, where it may be only a millimetre or two even with the longer periods of immersion.
By prolonging the duration of immersion, the degree of treatment obtained in pine sapwood in three minutes is about double that after 10 seconds: to double again, however, requires a period of longer than 30 minutes.
Long periods of soaking (more than an hour) are rarely used with organic solvent preservatives, but steeping in creosote is a convenient method of preserving farm and estate timber which may often contain a high proportion of permeable sapwood, eg round fence posts.
Dip treatments provide little protection to timber used under severe decay conditions. They are useful, however, when attack from fungi is less severe but they are usually used only with pine sapwood, which is more permeable than other softwoods such as whitewood and hemlock. A three-minute dip treatment is suitable for protecting pine external joinery that is to be painted in service, whilst a one-hour immersion is accepted for pine cladding. Immersion treatments are also suitable for protecting internal structural timbers, particularly against insect attack.
One other form of treatment that can be included here is concerned with the use of bodied 'mayonnaise-type' preservative emulsions. These are normally used for *in-situ* remedial treatments, being applied as complete coatings or in ribbons. As the emulsion breaks down on the surface of the timber, organic solvent preservative is released and penetrates into the wood. The treatment obtained can approach that from long-term soaking in conventional organic solvent preservatives.

Double-vacuum
The timber is placed in a treating cylinder, and a partial vacuum created and held for a few minutes before flooding with preservative. The vacuum is then released and the timber allowed to remain in the preservative fluid for up to an hour, either under atmospheric pressure or an applied pressure of up to 3 bar. After the preservative is emptied from the cylinder, a final vacuum is applied to the timber to recover some of the solution from the wood and to provide a dry surface. Organic solvent preservatives are used.
There is considerable scope in this operation for a variety of treatment schedules, giving different levels of preservative absorption and penetration. The minimum treatment cycle was developed primarily for use on redwood sapwood in external window joinery that is to be painted in service. An initial vacuum of minus 0·33 bar for three minutes is followed by a three-minute soaking of the wood in preservative at atmospheric pressure, ending with a high final vacuum. This treatment gives, in redwood sapwood, two to three times the absorption and penetration obtained from a three-minute dip.

Developments from the above schedule, using higher vacua and pressures above atmospheric for longer periods have taken place for two main reasons. For some hazardous situations, complete sapwood penetration and enhanced absorptions are required in redwood to provide satisfactory protection. More severe schedules have also been needed to give adequate treatment in the less permeable softwoods, spruce and hemlock.

The double-vacuum process can be used on timber for many environmental situations in building and constructional work and, provided the correct treatment schedule is applied, long-term protection against decay and insect attack should be obtained.

Hot and cold open tank

The timber is submerged in cold preservative (usually creosote), which is then heated to 85 to 95 °C and held at this temperature for one to three hours so that much of the air the wood contains is expelled. The timber remains in the preservative during cooling, when the residual air contracts and liquid is drawn into the wood. Practically the whole of the absorption occurs during the cooling period, which may last many hours before ambient temperature is reached. Modifications to the basic method can be made to reduce excessive uptake of preservative in easily-treated woods, or if the preservative decomposes when heated or contains inflammable solvents.

The process is used mainly on farms and estates for the treatment of fencing materials, and provides long-term protection.

Pressure

A pressure treatment is defined as one in which timber is placed in a closed cylinder and preservative fluid is forced into the wood by artificially applied high pressure, generally 10 to 14 bar. The process ensures that the sapwood of many timbers is penetrated completely but penetration into heartwood is not normally as deep and may vary considerably between different species of timber.

Pressure treatments provide reliable long-term protection in all situations where timber is exposed to biological attack; there are two main types:

The full cell process aims to leave as much preservative liquid as possible in the timber so that the void spaces in the penetrated zone are more or less completely filled. This is achieved by applying an initial vacuum to the timber in the cylinder before filling with preservative, and then applying pressure.

After a period of one to six hours, the pressure is released, the cylinder emptied and a final vacuum applied to help dry the surface of the wood. Creosote (at 65 to 95 °C) or copper/chrome/arsenic waterborne preservatives are normally used. In one instance, however, an organic solvent preservative based on liquefied petroleum gas is employed.

This process is often referred to as vacuum/pressure impregnation and, when creosote is used, as the Bethel process.

The empty-cell process employs no initial vacuum. Instead, air at atmospheric pressure (Lowry process) or up to a pressure of 4 bar (Rueping process) is present in the cylinder before and during filling with preservative (normally creosote at 65 to 95 °C). After the pressure period, the cylinder is emptied and a final vacuum applied which can recover a large proportion of the absorbed preservative. The wood spaces in the treated timber remain only partially filled with preservative although the actual depth of penetration with an empty-cell treatment is much the same as from a full-cell treatment.

Diffusion

This method of application can be used only on green timber and in this respect differs from the other methods described, all of which require seasoned timber. The diffusion method consists of applying a concentrated solution of a water-borne preservative (a highly-soluble boron salt is widely employed) to the surface of the wood and then stacking the timber for several weeks under cover to restrict drying. This allows the salt to diffuse into the planks and it is possible to obtain through-and-through penetration of preservative even in timbers which are very difficult to impregnate by any other method.

As the process can be employed successfully only with unseasoned timber, it has to be carried out in the country of origin at sawmills. The treated timber is imported into the United Kingdom: redwood and whitewood from Scandinavia and hemlock from Canada.

Boron treated timber is suitable for general building work where protection is required against decay or insects. It should not be used in contact with the ground or as unpainted components exposed to the weather, as the salt is soon lost by leaching, but it can be used where cladding and external joinery are to be painted in use.

Table 2 Treatments suitable for various uses

Use	Pressure (1)	Open tank (2)	Double-vacuum (3)	Diffusion (4)	Immersion (5)
Sea or fresh water	✓				
In contact with the ground	✓	✓			
External, but not in ground contact: —unpainted	✓	✓	✓		✓
—painted	✓†		✓	✓	✓†
Interior timbers in high humidity or subject to heavy condensation	✓†		✓	✓	
Internal timbers, against insects or with low risk of decay	✓†		✓	✓	✓†

1 Full-cell process: creosote or water-borne. Empty-cell process: creosote
2 Usually creosote
3 Usually organic solvent
4 Usually boron
5 Usually organic solvent; sometimes creosote
† Not creosote if timber is to be painted, or where staining of adjacent materials may occur

Selecting a method of treatment

A number of different ways of applying wood preservatives to timber are available.

It is of paramount importance that the correct preservative treatment is selected for a particular situation; some guidance is given in Table 2. It must be remembered, however, that where a number of treatments are given as suitable for a given use, some of the processes will provide more effective, reliable long-term protection than others. In addition, the type of preservative used and the species of timber to be treated can sometimes have a significant effect on the overall performance of the preserved timber. For detailed information, relevant standards should be consulted or technical advice sought.

Specifications

A number of British Standards are at present being prepared dealing with the preservation of timber, but until these are published it is impossible to give a comprehensive list of specifications relating to the preservation of timber building components. The following notes indicate existing suitable documents, which fall into two main categories.

End-use or commodity standards

These define suitable processes and preservatives for particular end-uses. The basic document is BS 5268: Part 5 *Preservative treatments for constructional timber*, which includes references to existing specifications for preservative solutions and treatments. In addition, British Standards for specific end-uses, such as joinery, cladding, fencing, etc., are being prepared.

The preservation of external window and door joinery is dealt with in PRL Technical Note 24 *Preservative treatments for external softwood joinery timber.*

Treatment standards

These generally define treatment requirements for a range of uses; some cover the preservative solution as well as the treating process.

Vacuum/pressure impregnation

BS 913 *Wood preservation by means of pressure creosoting*

BS 4072 *Wood preservation by means of water-borne copper/chrome/arsenic compositions*

Diffusion treatment

BWPA Standard 105 relates to the boron-diffusion method of treating softwoods.

Double-vacuum treatment

BWPA Standards 112 to 117 cover a number of commercial preservatives and treatments. PRL Technical Note 24 includes a double-vacuum specification which, although designed originally for external softwood joinery, can be used for timber in certain other situations.

Immersion treatment

No specifications exist dealing solely with immersion methods, but recommended treatment periods for some situations are given in BS 5268: Part 5, PRL Technical Note 24, and some BWPA Standards dealing with preservative solutions.

Documents referred to in this digest

British Standards

BS 144: 1973 Coal tar creosote for the preservation of timber
BS 913: 1973 Wood preservation by means of pressure creosoting
BS 1282: 1975 Guide to the choice, use and application of wood preservatives
BS 3051: 1972 Coal tar creosotes for wood preservation (other than creosotes to BS 144)
BS 3452: 1962 Copper/chrome water-borne wood preservatives and their application
BS 3453: 1962 Fluoride/arsenate/chromate/dinitrophenol water-borne wood preservatives and their application
BS 4072: 1974 Wood preservation by means of water-borne copper/chrome/arsenic compositions
BS 5056: 1974 Copper naphthenate wood preservatives
BS 5268: Part 5: 1977 Preservative treatments for constructional timber

Methods of applying wood preservatives, D. F. Purslow, £1.25, HMSO

Preservative treatments for external softwood joinery timber; PRL Technical Note 24; available from Distribution Unit, Building Research Station, Garston, Watford WD2 7JR

BWPA Standards are published by British Wood Preserving Association, 62 Oxford Street, London

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